Proposal for Energy Scan of Tevatron

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The Proposal

- 3 Energies proposed – listed in priority order
  - 900 GeV (~10M Various triggers)
  - 300 GeV (~10M Various triggers)
  - 630 GeV (as available)

- Want 1 interaction/crossing ~1e30
- If decent beam lifetime, should take about ~12-15 hours to collect the data sets of interest at each energy
- Would cap the program at 7 days -- if we finish faster, would just move to nominal HEP sooner.

Why?

- For a small investment in beam – a chance to make some valuable “legacy measurements”
- These are non-perturbative QCD; soft strong interactions with high σ
- This physics is less understood than high Et jets, W/Z or even top production
- Because of high XS (10’s of nb), investment in beam time is minimal. We can collect the data sets of interest quite rapidly
- Energy dependence is important – want to see evolution of number of charged particles, Pt spectra, development of underlying event etc…

Choice of Enegies…

- 900 – Can compare to SppS and LHC
  - LHC ran for a few days at injection energy
- 300 – Our injection energy which provides maximum lever arm for comparisons
- 630 – SppS and Tevatron Run ran here for a while – we now have much improved detectors and triggers)

- Would like to do all 3, but would be willing to restrict to fewer based on the time available.
- Not an all-or-nothing program. Don't need all 3 energies to be successful – each provides important information all by itself

Can we calibrate luminosity with W's

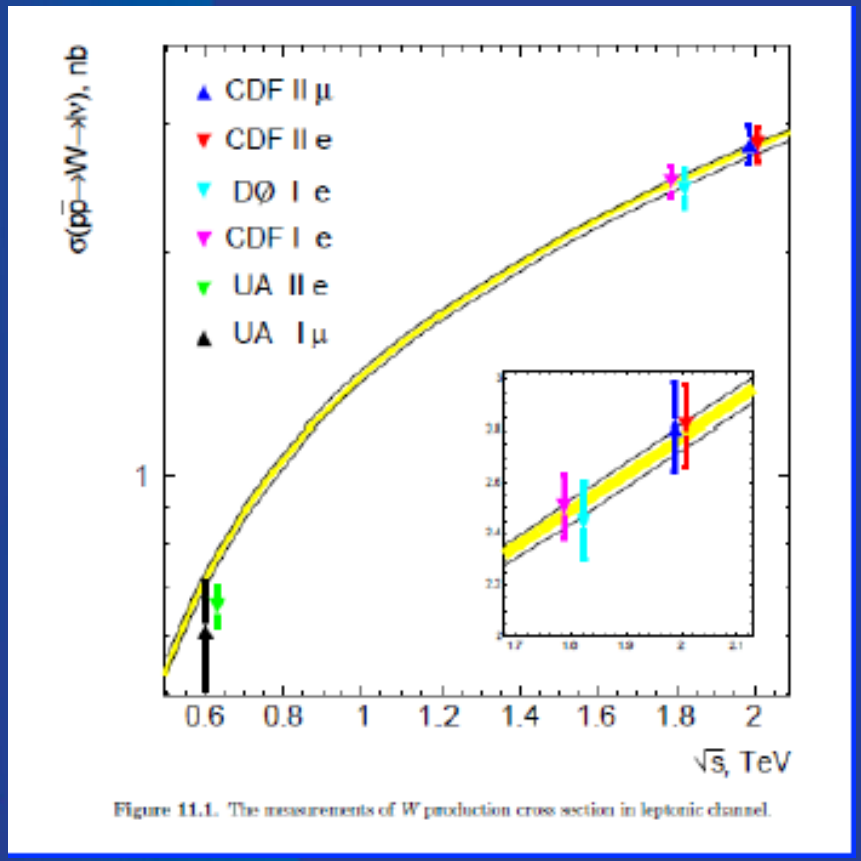


Figure 11.1. The measurements of W production cross section in leptonic channel.

$\sigma.B\,(W,1960) = 2.8$ nb

$\sigma.B\,(Z,1960) = 0.25$ nb

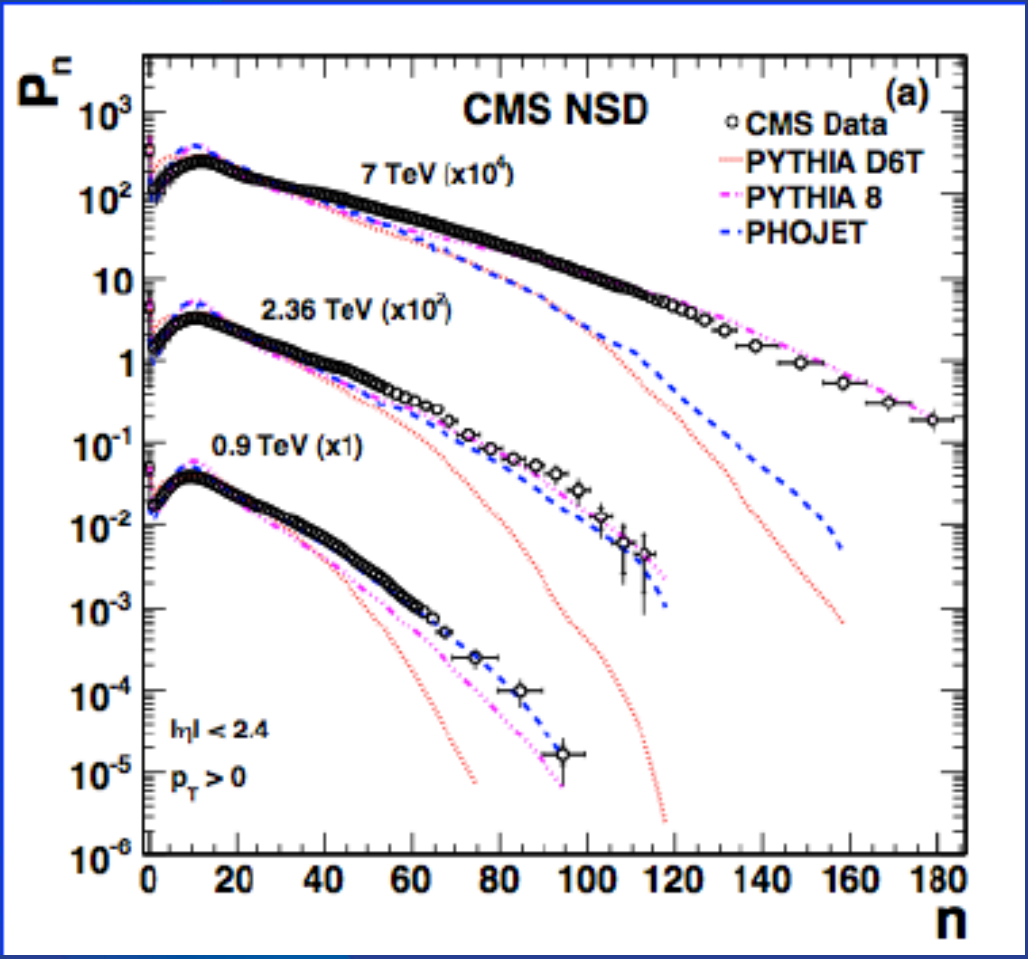
With μ-trigger and 20 GeV EM trigger will get 100's W's at 1960, at 900 a factor 3 lower.

The focus will be on shapes of distributions, not on the absolute cross sections – though we can make a reasonable estimate

3 Primary Studies We Want to Do/Publish

- Min Bias (incleds multiplicity distributions, charged particles pseudorapidity densities, average Pt, ….
- Exclusive Hadron Production
- Underlying Event Studies

Pythia Comparison



- Pythia – underlying event parameters need data to fit tunes
- Want both “N” in MB events and associated hard scatters (UE)
- In 10M MB events, N(η<1) > 60 at 900 GeV
- Our track trigger will enhance the tails!

Rise of particle multipliciities with sqrt S is not described by any model!

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Charged Particle Distributions for different Eta Regions

SppS : UA5, streamer chamber. Good coverage, no magnetic field
"Ramping run"

Very low statistics:
4156 MB/ND events at 200 GeV
6839 MB/ND events at 900 GeV

We can get 1000x these statistics!
At 300 & 900, $|\eta| < 0.5, 1.0, \ldots$
With p_T cut(s)

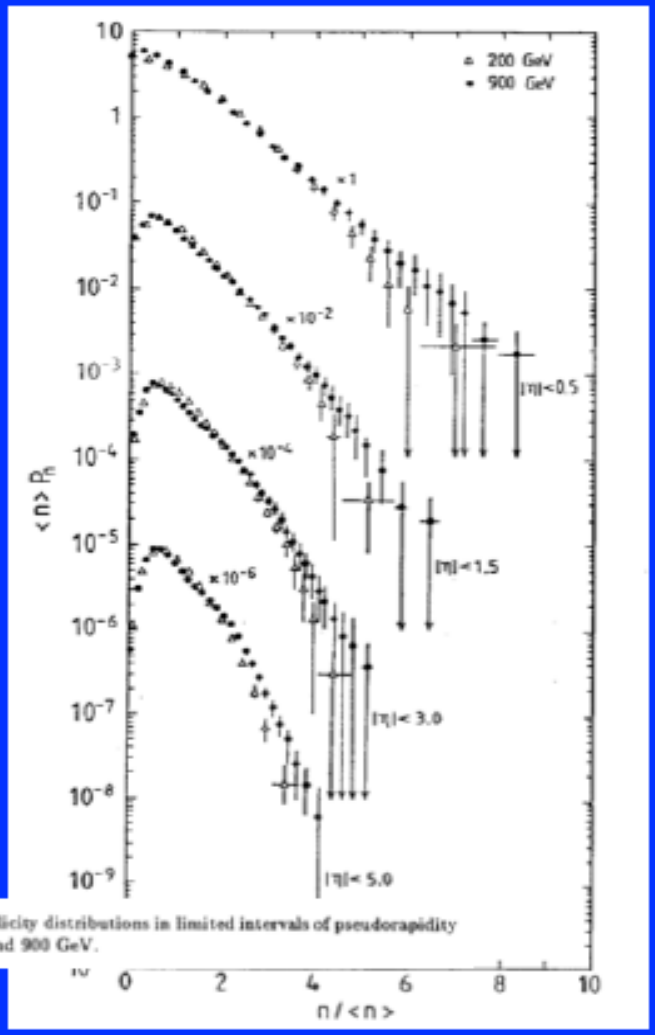

Figure 12: Charged particle multiplicity distributions in limited intervals of pseudorapidity at centre of mass energies of 200 and 900 GeV.

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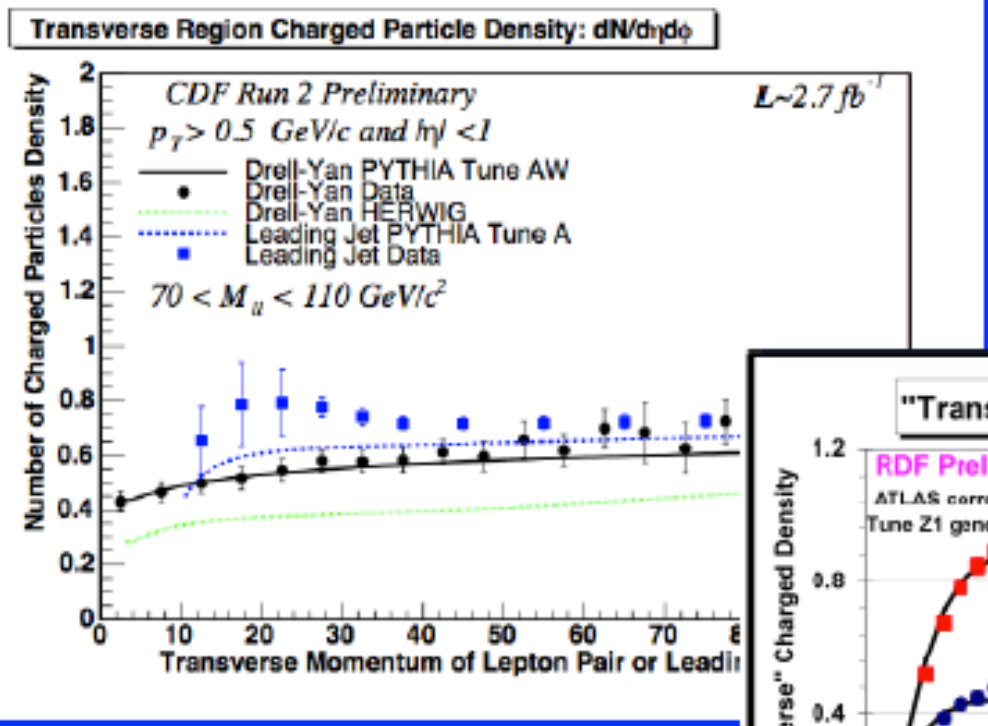
Underlying event UE to a hard scatter

Deepak Kar and Rick Field, PoS (HCP2009) 080.
one of many CDF studies

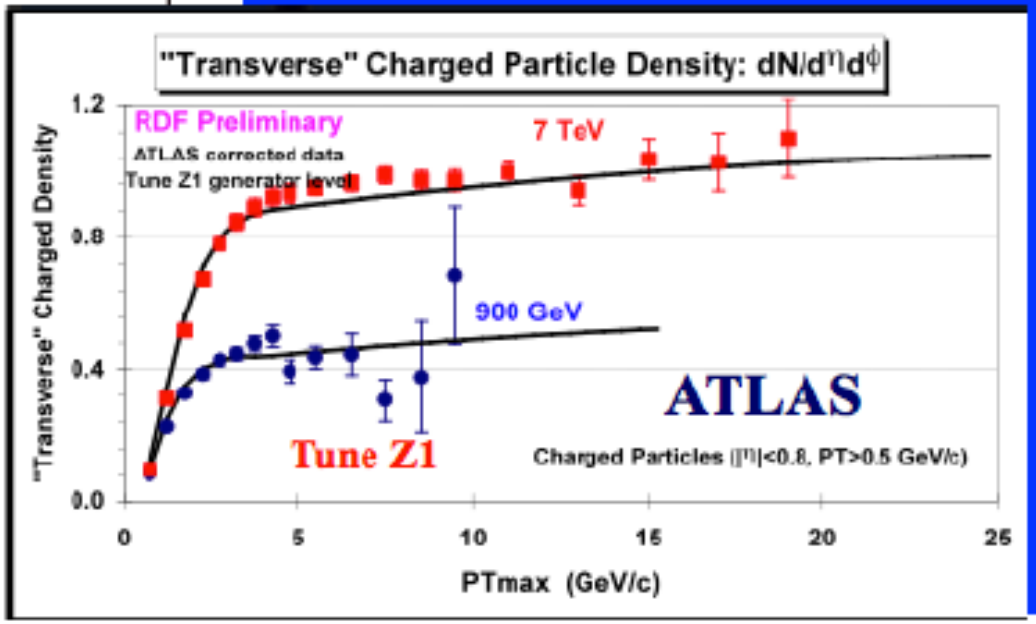
In 500/nb get ~ 50,000 jets with $|\eta| < 0.5$ and $95 < E_T < 105$ GeV

→ ~ 150 GeV at $\sqrt{s} = 1960$ GeV

Of course, << at low $\sqrt{s}$ ...



& ATLAS and CMS at 900 GeV



Other Topics…

- Charged mulitplicity distributions and charged pt spectra along with their correlations
- Underlying event with leptons and jets
- Central exclusive hadron production
- ΣEt spectra in $|\eta|<1,2,3$
- Shapes (Thrust, circularity, aplanarity) and emergence of jets
- Inclusive Et(jet) spectra, scaling violations
- Bose Einstein Correlations:size of pion emission region
- Charm production cross section
- You can think of more….!

Conclusions

- There is a lot of physics to be garnered from this energy scan
- We believe we can get a minimum of 3-4 papers from this week's worth of running – more if we can find additional analyzers
- The information acquired will help tune and better understand our MC simulations
- We believe the benefit of doing these studies outweighs the cost of 1 week of high Pt luminosity.